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Høringsuttalelse fra akademier

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Academia Europaea (AE) - Bergen, og Norges Tekniske Vitenskapsakademi (NTVA) har formulert en kort respons til høringen (vedlagt). Uttalelsen er også under vurdering hos Det Norske Videnskaps-akademi (DNVA), som vil ettersende svar.

Sincerely yours

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ACADEMIES AND THE NUCLEAR ENERGY FUTURE - NORWAY'S ROLE
"THORIUM AS AN ENERGY SOURCE – Opportunities for Norway"

Academies are not inward directed bodies for academicians; they have always been an outward directed resource for society and decision-makers. Thus the ***Mission Statement*** of Academia Europaea contains an obligation to: "*Promote better understanding among the public at large of the benefits of knowledge and learning, and of scientific and scholarly issues which affect society, its quality of life and its standard of living.*"

Academicians have taken part in the becoming of the atomic age and its development. In the post-war period academies have voiced their opinion about non-proliferation and disarmament, and warned against unrealistic safety measures such as missile shields (Star-Wars), as not being sufficiently knowledge based. Academicians have played central roles in making nuclear technology safe, including energy, and in introducing nuclear technology to a vast number of sectors in our civilian society.

Thus the three academies, jointly feel called on to give advice on Norway's future role in nuclear energy issues. With close to 450 nuclear reactors running worldwide, and close to 1/3 of Europe's power being nuclear, there are few or no reasons to believe that the nuclear energy age is coming to an end. More the opposite; There are indications of a new go, a new springtime for nuclear energy. It is a challenge, that academies share, to see that it is properly knowledge-based. Thus we support strongly the views expressed by the universities. Knowledge is a prime tool for making our choices sustainable, i.e. forward a development that *"meets the needs of the present generation without compromising the ability of future generations to meet their own needs"*.

In particular we are happy to see that the Thorium Report points out that Norway still has a fundament to build on, but also notice that we have to act now to preserve Norway's ability to have a qualified voice in the international community. It is also encouraging to see that future joint ventures with neighbours and Europe are available to help Norway renew its intellectual capital and installations in nuclear science and technology. Norwegian participation in international research and Norwegian know-how can provide new possibilities for Norwegian industries. The recent evaluation report on the cost-benefit value of Halden and Kjeller by the Hervik-committee concludes that a significant value will be lost if the reactors at Halden and Kjeller are terminated.

The Thorium issue has sparked off interest in wide circles, not only academic. This indicates that Norwegians not only think about adding to the safe operation of a nuclear society, but also recognize that other petroleum producing nations now start reactor programs, to save precious petroleum for the future. Nuclear power certainly does not produce CO_2 and has now also developed concepts for how to deal with, or burn its waste, such as plutonium. We support the view that Norway, with its potential future thorium resource and strong economy, has an opportunity to extend its role in promoting measures that make the world safer and cleaner, and thus consolidate Norway's say on nuclear issues.

The Annex contains a more detailed discussion of the report.

Approved by the Council of Academia Europaea (AE), by the Norwegian Academy of Technological Sciences (NTVA) and by the Norwegian Academy of Science and Letters (DNVA). May 2008.

Annex

“THORIUM AS AN ENERGY SOURCE – Opportunities for Norway”

I. Prelude.

The Thorium Report (TR) became available in February 2008. The report’s title contains the two central issues; (i) A composite international science-based question: Thorium as a potential energy source, its history, pros and cons, and its future potential; and (ii) A national challenge: Opportunities for Norway, today a major petroleum supplier, once a pioneer in nuclear power research, and with substantial unused, but largely un-assessed thorium ore in the ground. The report’s nine recommendations will be addressed below.

The report is very timely. Energy supply and energy security, also safety issues, are top EU priorities. EU is a major partner in forwarding development of Generation IV nuclear reactors, with a 30 years commercialization perspective. Presently, 1/3 of EU’s electricity is produced (170GWe) by 196 reactors, nearly half the number (439) in operation world-wide. To meet the energy challenge, scientific organizations have been called on and relationships to policy-makers have been strengthened, via bodies such as EASAC (European Academies’ Science Advisory Council) and the European Physical Society (EPS), which recently published its Position Paper “ENERGY FOR THE FUTURE – The Nuclear Option”. Thus, in assessing the TR we can draw upon highly competent statements by scientists with no involvement in the nuclear power industry. These scientists serve organizations meant to help society with scientific advice, without commercial self-interests.

Thorium is no newcomer in the history of nuclear power; It was considered as reactor fuel already from the very beginning in the 1950s, and its history is well documented in the TR. This includes a brief Norwegian thorium involvement, together with Sweden and Switzerland (p.42) in 1966-73, as partners in the UK/OECD-Euratom experimental HTGR (High Temperature Gas cooled Reactor) project *Dragon* in the UK (20 MWth), with Th and U-235 as driver fuel and coated fuel particles. Thus Norway has been more than just the site for the first discovery of thorium in 1823.

Thorium’s present revival in Norway, sparked off at Energy Foresight Symposium 2006 in Bergen, with follow-up meetings in the academies NTVA and DNVA, had particular focus on sub-critical Accelerator Driven Systems (ADS). Subsequently a wider range of more conventional reactor concepts has been addressed. Support from KVA/IVA in Sweden, from Finland, and the European networks mentioned above have created wider international attention. The public in Norway and the media have in particular been interested in two questions; (i) Does nuclear power need thorium, and, (ii) Does Norway need home-based nuclear power? The ongoing public debate has addressed both a country’s responsibility to explore its natural resources, and not least Norway’s moral obligation to have nuclear competence in the atomic age, and in a wide sense.

II. Nuclear Energy Competence in Norway.

Chapter 11 deals with the present situation. On (p.97) we are reminded that “The first (research) reactor in Norway was started at Kjeller in 1951, and made Norway a pioneering nation in nuclear technology. This is not so today, despite the high international status of the research reactor in Halden. Today *IFE* operates two old research reactors. Both are heavy water moderated and cooled. The thermal power of the Halden reactor is 20 MW, the Kjeller reactor thermal power is 2 MW.
The nuclear engineering development at *IFA* (now *IFE*) focused especially on nuclear reactors for ship propulsion and the development of computer codes for calculation of the fuel cycle and power distribution of power reactors. The computer codes were used in Germany, Switzerland, Sweden, Spain and USA.”

Thus, presently (p.98), “The only R&D environment for nuclear power in Norway is at *IFE*, primarily through the activity at the Halden reactor. The activity there is highly esteemed internationally, both regarding the fuel research at the reactor and the comprehensive research on the interplay between humans, technology and organization. IFE has extensive experience in fuel testing, including thorium-containing fuel.” , and (p.99) “Despite the fact that Norway has no commercial nuclear power plant, there is much competence in Norway concerning safety. This is partly due to the safety philosophy that has characterized the constructions in the North Sea, and the experience gained from accidents in the area. Furthermore, the OECD Halden Reactor Project is an important actor in the field of nuclear safety, both through the ongoing fuel research at the reactor, and through studies of the interplay between humans and technology in advanced laboratories where the effect of different systems and operator aids in simulated accident scenarios can be evaluated. The usefulness of the work within the Halden Reactor Project can be seen at Kola, where the safety of the Russian reactors has been significantly improved with the assistance of the Project”.   In conjunction with this the TR states on (p.96) that, “Norway has lost most of the specialists in nuclear energy technology after the nuclear moratorium more than 25 years ago.”

The way we read it, *this alarming assessment* certainly does not imply lack of ability to run a reactor and perform test experiments for component development, the Halden Project speaks for itself. Rather it refers to reduced competence in construction and building aspects of R&D and need for rejuvenation of the staff. Recommendation 3 (R3) testifies to this, “Testing of thorium fuel in the Halden Reactor should be encouraged, taking benefit of the well recognized nuclear fuel competence in Halden”. Concerning academia, the TR states (p.98) that many branches of science at the Norwegian universities use nuclear methods, and that several Norwegian university physicists and chemists do research and use methods relevant for reactor technology.

Thus, the committee identifies a national competence base and also mentions on (p.100) a recent coordination initiative, “The Norwegian universities, in close cooperation with IFE, are able to organize and provide courses in relevant nuclear physics, reactor theory, material science, radiation risk / protection and in reactor operation. A national strategy project between IFE, UiB and UiO has recently been established, to secure and re-establish a national competence in nuclear technology”.

We share the committee’s view that not all is lost, and that Halden as a home-base for initiating fuel cycle experiments with thorium should be tried. Still there is need for new governmental back-up for concerted action, for keeping the ground, not to say play a more visible role in nuclear energy related matters. The TR tells us that we cannot do this alone, “In general Norway today has few advantages in the field of nuclear energy, and is totally dependent on international cooperation. Cooperation within the *OECD Halden Reactor Project* is a possible starting point, but it is critically important to have other formal contacts with the international society”, (p.99).

We add, as also alluded to in the TR, that nuclear science and petroleum technology have a lot in common, the latter building on the former also by transferring technology, safety procedures and measures from the nuclear industry. In addition to the aspects mentioned in the report we may highlight the fields of momentum and energy transport (fluid mechanics and heat transfer), which play a central role in both nuclear technology and petroleum technology and in which there is considerable expertise in the Norwegian universities and scientific institutes, such as IFE , SINTEF and CMR. This is reflected in the present research profiles of both IFE and the universities, and may facilitate a larger reentry of nuclear energy in an extended Norwegian energy activity.

III. The Role of Intellectual Capital

There were divided opinions within academia concerning the early reactor ventures in the 1950s. The need for consensus building is exemplified by a famous letter from Professor Bjørn Trumpy to a key meeting on the Halden reactor in Ingeniørforeningen 10.02.1956. The letter finds little reason to fight over the largest piece of the cake: Rather one should join forces to provide for a bigger

cake! Although consensus seems not to be so much of problem today, the size of the cake is again a challenge if IFE and the universities are going to find together again in new joint ventures.
IFE and the Norwegian initiative relied on and was embedded within an international dimension, making it possible!

This is also what the TR calls for.

Projects with long implementation time have taught us that a mission oriented team has to be created, some kind of consortium, but embedded in and relying on the university structure. The Norwegian involvement in the European Organization for Nuclear Research (CERN) serves as a Big Science example of this. It is our impression that a thorium venture will not be short of young enthusiastic participants, if we give them a chance. Students have showed up in large numbers during the 'campaign' and also created their own 'Thorium clubs'. What is needed is to find realistic ways to bring it all inside the established institutions.

Inspired by the historical lesson, we stress that the necessary basic science underpinning the ventures cannot be sacrificed for their financing. With obligations to Norwegian CERN participation and to uphold forefront basic research, new investment capital is needed, both concerning money and people.

Recommendations R1 and R9 underline needed attitudes and a good portion of realism:
R1:"No technology should be idolized or demonized. All carbon-dioxide (CO2) emission-free energy production technologies should be considered. The potential contribution of nuclear energy to a sustainable energy future should be recognized."
R9:"Any new nuclear activities in Norway, e.g. thorium fuel cycles, would need strong international pooling of human resources, and in the case of thorium, a strong long-term commitment in university education and basic science. All these should be included in the country level strategy aiming to develop new sustainable energy sources. However, to meet the challenge related to the new nuclear era in Europe, Norway should secure its competence within nuclear sciences and nuclear engineering fields. This includes additional permanent staff at the universities and research institutes and appropriate funding for new research and development as well as a high quality research-based Master and Ph.D. education."

The essence of recommendation R1 is also emphasized by the EPS, and the plea in R2 for renewed human capital investments is extended to the European dimension, for safe operation of existing facilities, and if Europe wants to stay technologically abreast and with a strong say in future developments, in particular in Asia. R4 stresses the need to be part of these ventures quite concretely;
R4: Norway should strengthen its participation in international collaborations by joining the Euratom fission program and the GIF program for Generation IV reactors suitable for the use of thorium.

We find the TR's assessment of what is needed, to be a realistic guide for a venture within the European dimension. We have to utilize our existing networks, but more permanent competence has to be brought in from an international market which is itself short on human capital. This tells us that the venture will have to be a joint one, and no solo play. Nuclear power has become an economically very competitive way for large scale energy production.

IV. Thorium and a Safer World

The TR's list of collaborative opportunities is, however, very different from what was available to the pioneers half-a-century ago. Norway's economic situation is also quite different – and our investments ought at least to be able to match those during the post war period.
The report underlines that a Norwegian re-entry will be part of a needed and accelerated European joint venture, not only to provide energy, but also concerning operational safety, and efforts to

develop ways to get rid of unnecessary excess (and increasing amounts) plutonium (bomb material) and other radiating trans-uranic elements, resulting from our present uranium-based power (and weapon) production. The report addresses these important issues in its Non-Proliferation Chapter 9, and in the Executive Summary (p.3); "The thorium-uranium (Th-232/U-233) fuel cycles do not produce plutonium. Technically, one of the best ways to dispose of a plutonium stock pile is to burn it in a thorium-plutonium MOX fuel." - These perspectives appear to us to comply well with Norwegian political ambitions, and *should be reason good enough to investigate the thorium option further*. Disarmament goals still have to be fulfilled, close to 30 000 nuclear warheads remain.

The report discusses various ways to burn nuclear waste, in particular the sub-critical ADS (Accelerator Driven System) mentioned earlier, where thorium fuel again is an option. In an ADS, the sustainability of the nuclear fission reactions is made possible because of the presence of an external source (spallation target) of neutrons provided (induced) by the proton beam.

The present status in Europe is to have an exploratory ADS ready within 2020. Norway is invited to take part; The MYRRHA project being planned in Mol in Belgium seems a natural choice. Concerning economy for the various technologies, the committee (p.95) refers to running assessments by OECD/NEA which hitherto have concluded that energy production with ADS cannot compete economically with critical reactor technology. The ADS does however have advantages as element in a composite nuclear energy production picture (p.74):

"It can be concluded that accelerator-driven systems have additional safety margins, which give operational flexibility to future systems for safe and clean energy production and/or waste transmutation. The accelerator offers the possibility of applying a closed thorium cycle, but also for an open, once-through cycle using thorium oxide with some topping fuel and a very high fuel burnup."

V. Summary

Does nuclear power need thorium? Not just now, but probably in the not too distant future. The thorium report makes a valid case for thorium as a future fuel, and also addresses opportunities for Norway going beyond having thorium in the ground; Thorium offers perspectives for better waste handling, such as burning of actinides including and most importantly, plutonium. We find it well documented that thorium has advantages as future fuel, and Norway has a historic chance to promote a thorium based venture.

Does Norway need nuclear power production for the electric grid at home? The report offers no direct answer, but makes it clear that without home-based experimental activities, such as consolidating the Halden success story, it will be hard to uphold and develop research and research based training in the field. Norway is already approaching a point of no return after a nuclear moratorium more than 25 years ago.

The report also points out obligations that a nuclear moratorium made us partly forget. Norway simply has no option to leave the atomic age, and being a nation with international ambitions, also in the field of energy, is not expected to turn its back to this part of reality.

In a world with open markets, increasing commercialization and regulatory changes in the energy market, also the nuclear, it is important not to let this impede openness and weaken security. Large scale energy production and its waste handling, nuclear in particular, must remain a public concern. Society cannot rely on companies to uphold the full range of needed competence; Basic elements and training naturally belong to the tasks of universities and academia, the latter with particular responsibility for scientific conduct and leadership. This also applies to Norway.

The report shows that not all competence relevant to nuclear power is lost, but also that urgent action is needed - the age profile of the relevant staff at Norwegian universities tells that it may soon be too late – Norway has to get started now.

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